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STATE OF ALASKA

William A. Egan, Governor

ANNUAL REPORT OF PROGRESS, 1965 - 1966

FEDERAL AID IN FISH RESTORATION PROJECT F-5-R-7

SPORT FISH INVESTIGATIONS OF ALASKA

ALASKA DEPARTMENT OF FISH AND GAME
Walter Kirkness, Commissioner

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INTRODUCTION

This report of progress consists of Job Segment Reports conducted under the State of Alaska Federal Aid in Fish Restoration Project F-5-R-7, "Sport Fish Investigations of Alaska."

The project during this report period is composed of 18 separate studies. Some are specific to certain areas, species or fisheries, while others deal with a common need for information. Each job has been developed to meet the needs of various aspects of the State's recreational fishery resource. Seven jobs are designed to pursue the cataloging and inventory of the numerous State waters. These jobs, which are of a continuing nature, will eventually index the potential recreational fisheries. Four jobs are directed toward specific sport fish studies. These include specialized efforts toward the anadromous Dolly Varden of Southeastern Alaska, the silver salmon in Resurrection Bay, the king salmon stocks on the Lower Kenai Peninsula, the king salmon stocks in Upper Cook Inlet, and the Arctic grayling of the Tanana River system.

The statewide access program is developing rapidly. Our efforts in investigating existing and potential recreational sites and access has resulted in favorable action being taken on our proposals and recommendations submitted to the land management agencies at both the State and Federal levels.

The remaining jobs included a specialized creel census effort in Southeastern, an egg-take program designed to establish indigenous egg-take sources, and evaluation of the Fire Lake system.

Three special reports have been completed from past studies on the Dolly Varden study. These appear in the Department's "Research Report" series and are a direct result of the Federal Aid In Fish Restoration Program. To date, the following reports have been published: Research Report No. 3, "Some Migratory Habits of the Anadromous Dolly Varden Salvelinus malma (Walbaum) in Southeastern Alaska," 1965, Robert H. Armstrong; Research Report No. 4, "Annotated Bibliography on the Dolly Varden Char," 1965, Robert H. Armstrong; and Research Report No. 5, "Age and Growth of Anadromous Dolly Varden Char Salvelinus malma (Walbaum), in Eva Creek, Baranof Island, Southeastern Alaska," 1966, David W. Heiser.

The material contained in this progress report is often fragmentary in nature. The findings may not be conclusive and the interpretations contained herein are subject to re-evaluation as the work progresses.

Volume 7 Report No. 9-C-2

RESEARCH PROJECT SEGMENT

STATE: ALASKA Name: Sport Fish Investigations of Alaska.

Project No.: F-5-R-7 Title: Evaluation of the Fire Lake Hatchery Water Supply.

Job No.: 9-C-2

Period Covered: February 1, 1965 to January 31, 1966.

ABSTRACT

Studies to evaluate the Fire Lake Hatchery water supply have been reported in Volumes 4, 5 and 6, Jobs 8-C-3 and 9-C-2, Dingell-Johnson Project Reports, State of Alaska, 1962-63; 1963-64; and 1964-65. The present report is a continuation of these prior studies.

Water temperatures in Upper Fire Lake ranged from 33°F. to a high of 60°F. during the study period. The water temperatures in the hatchery closely corresponded to those at the 15-foot depth in Upper Fire Lake. Dissolved-oxygen concentrations in the hatchery ranged from 6.4 ppm to 11.0 ppm and the dissolved carbon dioxide concentrations ranged from 4.0 ppm to 15.0 ppm. The pH of the water in the hatchery ranged from 6.8 to 7.9 and corresponded to the pH range found at the 15- and 20-foot depths in Upper Fire Lake. Maximum ice cover on Upper Fire Lake was 31 inches during March. Spring breakup occurred in late April, 1965.

The hatching and rearing capacities of the facilities were computed, based on densities commonly used in salmon and trout hatcheries in other states. Insufficient data are available to determine the amount of water available throughout the year and the amount that can be delivered to the ponds. The capacities listed are considered preliminary, but can serve as guidelines until confirmation data can be obtained.

RECOMMENDATIONS

1. It is recommended that this project be continued with emphasis placed on the compilation and evaluation of past data, and that this data be summarized into a form that will yield guidelines for future hatchery expansion and operations.

2. It is recommended that periodic checks be made of the physical and chemical properties of the water supply. Flow data through the hatchery and in Fire Creek should be recorded systematically throughout the year to determine the maximum water consumption of the station in relation to available supply.

3. It is recommended that concrete block tanks be constructed in the hatchery to increase the indoor rearing capacity.

4. It is further recommended that a pilot experiment be carried out to warm the hatchery water during the period of low, cold water temperatures. Warmer water would alleviate egg and fry mortality during the critical incubation and hatching period and decrease development time.

OBJECTIVES

1. To measure seasonal flows from Fire Lake outlet stream.

2. To determine physical and chemical characteristics of the water at the intake tower and in the hatchery.

3. To continue observations on the dissolved gasses in water supply during the summer months.

4. To provide recommendations and procedures to fully utilize the water supply potential.

TECHNIQUES USED

Outside air temperatures were recorded throughout the year from a thermometer mounted on the north wall of the hatchery. Water temperatures were recorded inside the hatchery on a Taylor recording thermograph.

Water samples were collected for analysis from five depths near the intake tower on Upper Fire Lake and from the head and the foot of a trough in the hatchery. Dissolved-oxygen and pH tests were conducted using a Hach, direct reading colorimeter. Dissolved carbon dioxide concentrations were determined by the titration method. Snow and ice cover on Upper Fire Lake and water temperatures at all sampling depths were recorded on each sample date.

Aluminum trough aerators were placed in operation in May to alleviate the "gas bubble" disease that occurs during the summer months. The aerator is described in Vol. 4, Job No. 8-C-3, Dingell-Johnson Project Reports, State of Alaska, 1962-63.

FINDINGS

Upper Fire Lake

The water supply for the Fire Lake Hatchery is obtained from the intake tower in Upper Fire Lake. The intake is approximately 34 feet of elevation above the level of the hatchery. Water samples were collected from five depths (0, 5, 10, 15, 20) twice each month throughout the year. The samples were fixed and returned to the hatchery where they were analyzed for dissolved oxygen, carbon dioxide and pH. Water and air temperatures, together with snow and ice cover, were recorded for each sample date.

TABLE 1 - Water Temperatures and pH Readings from Five Depths of Upper Fire Lake, February 1965 to January 1966.

		Depth in Feet									
		0		5		10		15		20	
Date	Air	Water Temp. F.	pH	Water Temp. F.	pH	Water Temp. F.	pH	Water Temp. F.	pH	Water Temp. F.	pH
2/22/65	15	32	7.0	33	7.0	34	7.0	37	6.8	38	7.2
3/12/65	35	33	7.1	34	7.0	35	6.9	37	7.0	38	7.0
3/24/65	38	34	7.0	35	7.1	37	7.0	40	7.0	40	6.9
4/8/65	50	36	7.1	38	7.0	40	6.9	40	6.9	40	7.0
4/24/65	56	36	7.1	45	7.2	44	7.2	44	7.2	42	7.1
5/6/65	40	40	6.9	40	7.0	40	7.1	42	7.1	42	7.0
6/4/65	52	52	7.6	50	8.2	50	8.1	48	7.9	47	7.9
6/22/65	56	50	7.0	50	7.0	50	7.0	50	7.0	50	7.0
7/3/65	51	57	7.5	57	7.3	57	7.7	57	7.9	57	7.0
7/31/65	63	64	7.6	62	7.6	61	7.8	60	7.6	60	7.6
8/9/65	56	60	7.0	60	7.0	58	7.0	58	7.0	58	7.0
8/25/65	68	54	7.2	54	7.2	53	7.2	53	7.0	52	7.0
9/27/65	50	49	7.0	48	7.0	48	7.1	48	7.1	47	7.1
10/14/65	23	38	7.2	38	7.2	39	7.2	39	7.2	39	7.2
10/27/65	20	32	7.1	38	7.1	38	7.1	38	7.1	38	7.1
11/14/65	15	34	7.3	35	7.5	36	7.3	37	7.3	38	7.3
11/26/65	5	33	7.0	34	7.0	36	7.1	38	7.2	38	7.2
12/14/65	10	33	7.0	34	7.1	36	7.1	38	7.1	38	7.1
12/27/65	3	33	7.1	34	7.1	36	7.2	37	7.2	38	7.2
1/14/66	1	33	7.1	34	7.0	36	7.0	37	7.0	38	6.9

TABLE 2 - Dissolved-oxygen and Carbon Dioxide Concentrations from Five Depths of Upper Fire Lake, February, 1965 to January, 1966.

Date	Depth in Feet									
	0		5		10		15		20	
	DO	CO_2	DO	CO_2	DO	CO_2	DO	CO_2	DO	CO_2
2/26/65	7.2	---	6.8	---	5.8	---	5.7	---	4.6	---
3/12/65	5.7	---	5.2	---	4.9	---	4.9	---	3.8	---
3/24/65	8.1	8.0	7.8	8.0	6.9	9.0	5.4	10.5	5.0	7.5
4/8/65	9.0	8.0	7.6	16.0	6.5	14.0	5.5	12.8	6.2	12.1
4/24/65	5.0	11.0	5.5	10.0	5.5	10.5	5.3	9.0	6.4	11.5
5/6/65	9.0	15.1	8.9	10.0	8.9	9.0	9.0	9.0	8.5	8.0
6/4/65	11.0	11.0	11.2	9.1	10.8	10.0	10.0	12.3	10.0	10.0
6/22/65	11.1	12.0	11.3	12.0	11.3	12.0	12.0	12.0	11.8	12.0
7/3/65	11.5	11.7	11.3	11.6	11.0	11.3	11.0	11.0	10.8	12.1
7/31/65	9.5	15.0	9.5	14.0	10.5	15.0	10.8	15.2	11.3	14.8
8/9/65	11.0	8.0	9.5	8.0	10.0	8.0	10.3	8.0	11.0	8.0
8/25/65	9.2	8.0	9.2	8.0	10.0	8.0	10.3	8.0	11.0	8.0
9/27/65	8.1	6.0	8.1	6.0	8.0	5.0	7.8	6.0	7.7	6.0
10/14/65	8.8	5.0	8.5	5.0	8.3	4.0	7.9	4.0	8.5	4.0
10/27/65	10.0	4.0	9.5	4.0	9.0	5.0	9.0	5.0	9.0	4.0
11/14/65	8.0	---	8.8	10.0	8.8	8.0	7.5	9.0	7.8	11.5
11/26/65	10.6	5.0	9.8	8.0	9.1	9.0	9.1	10.0	8.9	10.0
12/14/65	9.2	9.0	8.5	10.0	8.5	10.0	8.4	11.0	8.4	11.0
12/27/65	8.1	8.1	7.5	9.2	7.5	9.1	7.4	9.0	7.4	9.0
1/14/66	9.2	7.9	9.0	7.9	8.4	8.0	8.3	9.3	7.8	10.1

Maximum water temperatures at all depths occurred during late July while minimum temperatures were recorded during February (Table 1).

The highest pH readings at all depths from Upper Fire Lake occurred in June and again in November. The lowest pH readings were recorded at the 15-foot depth during February and March (Table 1).

The analysis of the dissolved-oxygen data collected from the five depths in Upper Fire Lake revealed that during the winter and spring of 1965 the dissolved-oxygen concentration gradually declined to the 15- to 20-foot depths (Table 2). During the spring overturn, the lake rapidly took on oxygen and averaged about 11.0 ppm during the summer months. A high of 12.0 ppm occurred on June 22, 1965 at the 15-foot depth. Dissolved-oxygen concentrations gradually diminished again after the fall overturn.

Carbon dioxide concentrations at all test depths in Upper Fire Lake ranged from 4 to 16 ppm throughout the year (Table 2). The highest concentrations were recorded at the five-foot level in April while the lowest reading occurred in October and November at all test depths.

Snow depths on Upper Fire Lake fluctuated between each sample period because of new snowfall and melting or settling of existing snow. The deepest snow depth was 12 inches on December 27, 1965 (Table 3).

TABLE 3 - Snow and Ice Depths in Upper Fire Lake, February 1, 1965 to January 31, 1966.

Date	Depth in Inches	
	Snow	Ice
2/26/65	4	29
3/12/65	6	31
3/24/65	0	30
4/8/65	0	20
4/24/65	0	8
	Ice out 4/29/65	
	Ice cover 10/20/65	
10/27/65	1	5
11/14/65	2	14
11/26/65	4	20
12/14/65	5	24
12/27/65	12	24
	10	27

Ice began forming on Upper Fire Lake in late October and reached a maximum thickness of 31 inches on March 12, 1965. Ice breakup occurred on April 29, 1965 (Table 3).

Fire Lake Hatchery

The pipeline that supplies water to the hatchery from Upper Fire Lake is eight inches in diameter, above ground, and uninsulated. Water temperatures recorded immediately upon entering the hatchery ranged from 36°F. in February to 60°F. in August (Table 4). The vertical manipulation of the intake pipe in Upper Fire Lake and/or the adjustment of the discharge rate of water through the bypass valve maintained hatching and rearing temperatures throughout the year.

TABLE 4 - Hatchery Water Temperatures, February 1, 1965 to January 14, 1966.

Month	Water Temperature in Degrees F.		
	High	Low	Average
February	39°	36°	38°
March	40°	37°	39°
April	43°	38°	40°
May	51°	39°	45°
June	54°	46°	52°
July	59°	51°	57°
August	60°	49°	55°
September	55°	44°	50°
October	48°	38°	43°
November	40°	38°	39°
December	39°	38°	38°
January 14	39°	38°	38°

Only slight differences in dissolved-oxygen concentrations occurred between the head and the foot of the troughs during 1965. The lowest oxygen reading in the hatchery troughs was 5.7 ppm in late March (Table 5). The aluminum aerators increased the dissolved oxygen in the troughs and decreased the dissolved nitrogen to a safe level.

The pH and carbon dioxide concentrations did not vary significantly between the head and the foot of the troughs throughout the year (Table 6).

The maximum summertime air temperature was an 83°F. reading recorded on July 26, 1965 and the minimum was -16°F. recorded on December 22, 1965 with the year around mean temperature being 38.9°F. (Table 7).

Hatching and Rearing Capacities of Fire Lake Hatchery

The hatching and rearing capacities of the facilities were computed, based on densities and capacities commonly used in salmon and trout hatcheries in other states. Insufficient data are available to determine the amount of water available throughout the year and the amount which can be delivered to the ponds. Therefore, the capacities listed here must be considered preliminary, but can serve as guidelines until these data can be obtained.

TABLE 5 - Dissolved-oxygen Concentrations from the Head and Foot of the Trough in the Fire Lake Hatchery, February 1, 1965 to January 14, 1966.

Dates	Dissolved-oxygen Concentrations in ppm	
	Head of Trough	Foot of Trough
2/26/65	6.6	6.2
3/12/65	6.4	5.8
3/24/65	5.7	5.7
4/8/65	6.5	6.1
4/24/65	9.0	8.5
5/6/65	7.5	6.0
6/4/65	10.2	8.9
6/22/65	10.1	8.5
7/3/65	10.8	10.6
7/31/65	10.2	10.5
8/9/65	10.0	9.5
8/25/65	9.3	11.0
9/27/65	7.5	7.9
10/14/65	8.8	8.6
10/27/65	8.8	8.6
11/14/65	7.1	7.1
11/26/65	8.8	8.7
12/14/65	7.9	7.5
12/27/65	7.2	6.2
1/14/65	7.3	6.7

TABLE 6 - Dissolved Carbon Dioxide and pH from the Head and Foot of the Trough in Fire Lake Hatchery, February 1965 to January 1966.

Date	Head of Trough		Foot of Trough	
	CO_2 in ppm	pH	CO_2 in ppm	pH
2/26/65	---	6.8	---	7.2
3/21/65	---	7.0	---	6.9
3/24/65	8.0	6.8	8.0	6.8
4/8/65	12.0	7.0	14.0	7.0
4/24/65	11.0	7.1	12.0	7.0
5/6/65	10.0	7.0	12.0	7.0
6/4/65	11.0	8.2	15.0	7.9
6/22/65	12.0	7.0	12.0	7.0
7/3/65	11.5	7.4	11.3	7.4
7/31/65	15.0	7.6	15.0	7.6
8/9/65	8.0	7.6	8.0	7.4
8/25/65	9.0	7.6	9.0	7.4
9/27/65	---	7.1	---	7.0
10/14/65	4.0	7.2	5.0	7.2
10/27/65	4.0	7.1	5.0	7.1
11/14/65	11.8	7.3	11.2	7.2
11/26/65	10.0	7.1	10.1	7.1
12/14/65	10.0	7.0	12.0	7.1
12/27/65	9.1	7.1	10.0	7.1
1/14/66	9.0	7.0	11.2	6.9

TABLE 7 - Air Temperature in Degrees Fahrenheit at the Fire Lake Hatchery, February 1, 1965 to January 31, 1966.

Month	High	Low	Mean
February	40	-12	25.5
March	52	10	36.8
April	68	10	38.2
May	76	21	45.0
June	78	34	53.6
July	83	40	62.1
August	80	32	65.9
September	73	23	49.7
October	50	3	26.3
November	41	-4	16.9
December	39	-16	10.6
January	24	-15	-6.0

Hatching Capacity

Incubators:

Each Heath incubator tray can be safely stocked with 80 ounces of eggs. There is a total of 96 trays that may be stocked with 7,680 ounces of eggs to be carried to the "swim-up" stage. This volume of eggs is converted to a number of different species in Table 8.

TABLE 8 - Capacity of Heath Incubators at Fire Lake Hatchery.

Species	Number of Eggs/Ounce	Number of Eggs/Tray	Total No. Eggs in 96 Trays
King Salmon	60	4,800	460,800
Silver Salmon	100	8,000	768,000
Rainbow Trout	350	28,000	2,688,000

Troughs:

1. If troughs are not equipped with screened hatching trays, and the fry drop from baskets into the troughs, the hatching capacity should be restricted to the carrying capacity for rearing fry.

2. If troughs are equipped with screened hatching trays, each trough may contain five stacks of five trays each, and each tray may be stocked with 64 ounces of eggs until "swim-up." The tray, trough, and combined trough capacities for different species are listed in Table 9.

TABLE 9 - Incubation Capacity of Troughs at Fire Lake Hatchery.

Species	Number of Eggs/Oz.	Number of Eggs/Tray	Number of Eggs/Trough	Total No. Eggs 38 Troughs
King Salmon	60	3,840	96,000	3,648,000
Silver Salmon	100	6,400	160,000	6,080,000
Rainbow Trout	350	22,400	560,000	21,280,000

Rearing Capacity

Troughs:

The aluminum troughs are operated with a 7-inch water depth, which provides a total volume of 8.75 cubic feet of water. Maximum density of fingerlings in a trough should not exceed two pounds per cubic foot of water; therefore, the maximum weight of fish per trough would be 17.5 pounds. The number of fish by weight at different sizes in relation to total trough rearing capacity by number is shown in Table 10.

TABLE 10 - Rearing Capacity of 38 Troughs at Fire Lake Hatchery.

Fish Size	Number/Trough	Total Number (38 Troughs)
3,000/lb.	52,500	1,995,000
2,500/lb.	43,750	1,662,500
2,000/lb.	35,000	1,330,000
1,500/lb.	26,250	997,500
1,000/lb.	17,500	665,000
800/lb.	14,000	532,000
600/lb.	10,500	399,000
400/lb.	7,000	266,000
200/lb.	3,500	133,000

Fish of the sizes listed above should be provided with a minimum flow of one gallon per minute (gpm) of water for each five pounds of fish. Therefore, at least 3.5 gpm inflow per trough is required, and with two troughs in series, 7 gpm should be delivered to the uppermost trough.

Ponds:

The volume of water in the 25-foot circular ponds at various depths is listed in Table 11.

TABLE 11 - Volume of Water in One 25-foot Circular Pond at Various Depths.

Depth	Cubic Feet	Gallons
0.5 ft.	245.3	1,835
1.0 ft.	490.6	3,670
1.5 ft.	735.9	5,505
2.0 ft.	981.2	7,340
2.5 ft.	1,226.5	9,175
3.0 ft.	1,471.8	11,010
3.5 ft.	1,717.1	12,845

The maximum density in ponds for fish smaller than about 100 per pound should not exceed one pound per cubic foot of water, although a maximum density of two pounds per cubic foot is satisfactory for larger fish. If the ponds are operated at a 3.5-foot water depth, the maximum load would be 1,717 pounds of fish.

The most realistic method of determining pond stocking rates is based on the quantity of incoming water. In using this method, pond capacities will depend entirely upon inflow until the density limit of one pound per cubic foot is reached, then density becomes the limiting factor. A good rule of thumb is that fish at a size of 500 per pound and smaller should be provided with a flow of 1 gpm for each 5 pounds of fish and for fish 100 per pound and larger they required 1 gpm for each 10 pounds of fish. If the maximum pond density of about 1,700 pounds of fish is to be achieved, an inflow of 170 gpm will be required if fish are 100 per pound or larger, but if they are 500 per pound or smaller, about 340 gpm to each pond will be necessary.

Additional data on the quantity of water that can be delivered to the ponds and more data on normal growth pattern of fish in the hatchery must be compiled to provide realistic pond rearing capacities.

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